How Can a Computer be Useful to You?
A Feasibility Study to Elicit Perceptions of Computers in Rural India

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Abstract

The growing influx of information and communication technologies (ICTs) into rural India provides new opportunities for the prevention and treatment of diseases across millions of residents. However, little is known about how rural Indians with little or no exposure to computers perceive computers and their uses, and how best to elicit those perceptions. Such perceptions could lead to new insights for using ICTs to affect health behavior change in developing countries. We therefore developed a semi-structured interview approach to probe how residents of a north Indian village perceived computers and their uses. The results suggest that besides helping to overturn several assumptions of the researchers through unexpected insights, the approach could be easily implemented in rural settings, which could lead to deeper insights for developing future culturally and medically-relevant ICTs for rural residents.

Introduction

Similar to many parts of the developing world, almost 70% of Indians live in villages[1] where high illiteracy, low income, and under-developed healthcare infrastructures are common[2]. Furthermore, while residents of highly publicized urban centers like Mumbai and Bangalore use and develop cutting-edge information technologies, there exists a huge digital divide that separates them from those that live in rural communities.

For decades, such challenges in India and other developing nations have appeared insurmountable. However, in recent years there has been a sea shift in thinking about how to address this digital divide, with innovative solutions targeted towards people at the "bottom of the pyramid" [3]. These innovations have spontaneously emerged across many developing countries and appear to be successful because they: (1) pay close attention to the needs of the target population, (2) directly deal with the high rate of illiteracy, low income, and poor infrastructure, and (3) are economically sustainable through creative business models that involve the local communities. For example, researchers in South Africa identified the need for a device to help animal trackers record their observations through an interface that did not require literacy[4]. The device not only improved the trackers' skills and raised their prestige, but was also used for conservancy efforts by several organizations making the project economically sustainable. Similarly, systems have been built to help illiterate and semi-literate users keep track of micro-economics records[5], and to help illiterate farmers get advice from remote agro-experts using the internet through intermediaries[6].

While the above researchers have been successful in designing and introducing ICTs in rural settings, few studies have explored how to elicit uses of computers directly from rural residents. For example, could a farmer with no formal education, and who had never seen or used a computer before, be able to suggest ways to use a computer? How would this view change after having seen applications running on a computer, and could such perceptions impact the design of culturally-relevant solutions? Given the early stages of healthcare infrastructure of rural communities in developing nations[2], and the importance of understanding how users perceive the value of ICTs to their daily lives, addressing such questions are critical to enable medical informaticians to more fully exploit opportunities for impacting the health of millions of rural residents. As stated by Douglas et al. [7] after eight years of development and deployment of an electronic medical system in the developing nation of Malawi: "*[users] will not adopt a system if they do not find sufficient value in it. Consequently, we believe that the primary challenge is to identify and address the value proposition for the user.*" (p. 5).

Given the importance of understanding the value proposition of users, we describe a feasibility study to probe how rural residents, of varying educational and computer backgrounds, perceived computers and their uses before and after seeing demonstrations of computer applications. We begin by describing our motivation and design of an easy-to-implement semi-structured interview approach to elicit concrete responses to questions about computers. Next, we report the results from an analysis of the tape-recorded interviews, field notes, and photographs collected during the study. We then discuss how the study helped to challenge our assumptions of the rural residents, the value of the interview approach, and what implications the results have for medical informaticians. We conclude with why we believe the interview method can be easily implemented in rural settings, which could lead to deeper insights for developing future culturally and medically relevant ICTs for rural communities.

Adoption of Information and Communication Technologies in Rural India

While there has been a history of empirical studies and theoretical frameworks developed to analyze the key factors related to technology acceptance in developed nations[8], it is only recently that similar research has been conducted in developing nations. In particular, studies of ICTs in rural India have begun to reveal a complex picture of how rural Indians perceive ICTs. For example, a recent study showed that many illiterate Indians have embraced ATMs because it avoids contact with human tellers, who tend to perpetuate social class distinctions[9]. Other researchers have used Hofstede's[10] theory of cultural dimensions to explain behaviors that would otherwise be perplexing from a Western perspective. For example, Indians are reluctant to criticize new products due to a high power distance that exists between social classes[11]. Furthermore, Indians tend to be comfortable in sharing technologies such as cell phones because the Indian culture values *collectivism*[10]. Finally, rural Indian women have shown strong entrepreneurship abilities in effectively managing micro-loans, and have responded positively towards the use of modified cell phones to help improve the maintenance of their accounts[12]; similarly Indian children quickly acquired the skills to use browsing and drawing applications within a month of unguided and unsupervised access[13].

While the above studies have begun to reveal complex interactions of gender, age, and social class with the adoption and use of specific ICT implementations, little is known about how rural Indians perceive the potential role of computer applications in their lives, especially those that have never seen or used a computer. Furthermore, little is known about methods that could easily elicit such perceptions. We were therefore motivated to ask the question:

> *How do rural Indians with little or no exposure to computers, perceive computers and their uses, and how best to elicit those perceptions?*

Design of the Semi-Structured Interview

Semi-structured interviews are a well-known qualitative method[14,15,16] used in a wide range of fields including human-computer interaction, sociology, and medical informatics. The method is most useful when topics of research interest have been identified, but there is a lack of understanding of those topics to ask structured questions such as in a survey. The goal of the semi-structured interview method is on the one hand to focus an interview based on an ordered list of predetermined questions, and on the other hand to enable the interviewer to explore issues that emerge during the interview, often leading to unexpected insights. This is achieved by asking open-ended predetermined questions to enable users to discuss a topic. Depending on the answers, open-ended questions are then often followed opportunistically by carefully worded non-leading prompts to encourage continued elaboration, and probes to explore emergent issues or to guide the discussion in promising directions. Such interviews typically amass a large amount of in-depth qualitative data, and the studies are generally conducted with tens rather than hundreds of participants.

While semi-structured interviews are a powerful means to elicit complex views, we were concerned whether the approach could be effective to solicit perceptions of computers from rural residents who had little or no exposure to computers. Furthermore, the method is dependent on language and its nuances to convey complex concepts, which can be a hurdle if the researcher is not fluent in the language of the participants. Finally, semi-structured interviewers require skill in knowing how to steer a conversation without biasing the responses[14].

To address these issues, and heeding guidelines for international interface design[17], we collaborated with two experts from a large Indian university who specialized in rural studies, and with an Indian male student who was a native speaker of the language in which the interviews were ultimately conducted. Our goal was to design and use a flexible, easy-to-learn method to effectively probe the perceptions of rural Indians.

Discussions within our team on the appropriate method to elicit responses from rural Indians who have never seen a computer, led to divergent views. On the one hand, some believed that questions asked in the style of in-context open-ended interviews would be adequate to quickly elicit rich responses. On the other hand, others believed it would be difficult for respondents who had never seen a computer to articulate their perceptions. The latter view was informed by research in learning transfer which has shown that humans need more than one instance of a concept (e.g. chair, table) before they can form an abstract representation (e.g., furniture), a pre-requisite for generating new instances of the concept[18].

We decided to incorporate both approaches resulting in a format where the participants were asked two questions about computers before and after a demonstration of computer applications. The goal of this format was to elicit baseline perceptions of computers and their users before interacting with a computer, and then after to understand how the demonstration affected their perceptions. Differences in answers could reveal perceptions of rural

participants without and with the benefit of seeing an actual computer, and therefore reveal whether and how the method was useful. The following 4 steps describe the resulting method we designed and used for the study:

1. Introduction. To best understand the participants in their own context, the interviews were conducted in the participants' homes in the presence of family members. The interview began with explaining the purpose of the study which was to understand how we could help the village. This was followed by demographic questions of variables shown in Table 1, along with permission to record the conversations, and to take photographs.

ID	Sex	Age	Occupation	Education	Comp. Exp.
P5	F	18	Student	BA 2nd yr.	Word, Excel
P1	F	45-50	Sells sweaters	5th std.	None
P7	F	40	Homemaker	None	None
P8	F	45	Homemaker	None	Seen
P10	F	35	Homemaker	None	None
P11	F	40	Homemaker	None	Heard
P6	M	14	Student	11th std.	Word, Excel
P2	M	65	Farmer	6th std.	Seen
P3	M	40	Sells Stones	BA	None
P4	M	45	Sells Corn	10th std.	Heard
P9	M	60	Farmer	None	Heard

Table 1. Demographics of the 11 participants in the study.

2. Pre-demo Questions. After the introduction, the interviewer asked **Question-1**: *In your view, what is a computer?* The participants were encouraged to respond freely, and if they had seen or used a computer before, then they were asked to elaborate on those encounters. After the discussion reached a natural closure, the interviewer used the same open-ended approach to ask **Question-2**: *In your view, how can a computer be useful to you?*

3. Computer Demos. After the above two pre-demo questions, the interviewer opened a laptop, and described it as a computer which had a screen and buttons. He then demonstrated 4 applications: (1) A slide show of eight digital photographs of the village and well-known village personalities taken prior to the study, (2) a Hindi song played with Media Player, (3) a calculation using Microsoft Excel, with which they were encouraged to interact (as shown in Figure 1), and (4) a literacy program that showed Hindi alphabets and words with their audio pronunciations. The interviewer then took a photograph of the participant, and explained that similar to the laptop, the digital camera was also a computer with a screen and buttons. These computer application demonstrations were carefully selected based on the recommendations of the rural experts to be culturally relevant and to provide enough breath to facilitate the construction of a generalized concept of a computer and its extrapolation to new relevant uses.

4. Post-demo Questions. After the demonstrations, the laptop and digital camera were put away. Using the same open-ended interview format, the participant was then asked **Question-3**: *Now that you have seen a computer, what in your view is a computer?* This was followed by **Question-4**: *Besides the uses of computers that you just saw, how can a computer be useful to you?* The interviewer had natural variations in all four questions to clarify their meaning when needed.

During the discussions with the rural experts, we also recorded five assumptions about how the residents would respond to the above semi-structure interview: (1) All residents would have difficulty answering Question-1 given its abstract nature. However, after seeing and interacting with a computer, we assumed that they would have less difficulty in answering Question-3. (2) Adult residents would be more interested in computer uses for their children's future rather than for themselves when answering Question-2. This assumption was based on the fact that there were three computers in the local school, and Indian parents in general tend to value education for their children. (3) Adult residents would have difficulty in extrapolating computer uses outside those that were demonstrated when answering Question-4. This assumption was based on their low exposure to computers. (4) Younger residents would be more enthusiastic towards, and have more knowledge about computers compared to the adults when responding to all the questions. This was because we assumed that the younger residents had fully exploited the opportunity to use computers in their local school. (5) The adult women would be the least responsive to the questions. This assumption was based on our knowledge that rural Rajasthani women were conservative, covered the top half of their faces with their sarees when talking to strangers, and would have difficulty being conversant with the study team who looked and spoke like outsiders.

Figure 1. A participant with no formal education interacting with a computer for the first time.

Execution of the Semi-Structured Interview

Site Selection. We chose to study a village with approximately 7000 residents, 40 kilometers from Udaipur, a city in the north-western Indian state of Rajasthan. The residents consisted of approximately 4500 adults (>18 years), and approximately 2500 children (<=18 years). Farmers formed the majority of the population (70%), while the rest were divided into shop keepers, laborers, and professionals. The village had three computers in a school, and none of the residents had used the Internet. The choice of this village was opportunistic because a team member's grandfather (a well-respected local teacher) lived in the village, and agreed to host our visit. This we believed would allow us to rapidly meet important people in the village, and to build trust with the local residents, a highly recommended goal in field studies[19]. Because the village residents had low exposure to computers, and no experience with the Internet, we believe they represent the profile of many rural residents in India and in the world.

Sample Selection. Our initial plan was to do a random selection of the village residents stratified by gender, age, and occupation. However, a discussion with the school principal revealed that this approach was impractical because: (1) we had access to only a printout consisting of voting members which excluded children; and (2) many residents would not be available at home leading to an inefficient use of the two days we could spend in the village. We therefore relied on the school principal to select a cross-section of residents whom he knew would be available for the interviews. Because the illiteracy rate was high (55%), he made sure that close to half of our sample was illiterate. He also included two students.

Table 1 shows the sample of residents that was interviewed. This sample consisted of 6 women, and 5 men ranging in age from 18 years to 65 years. Of the 6 women, five were housewives (only one of whom had a formal education), and one was a college student. Of the 5 men, two were farmers, two were shopkeepers, and one was a student. All except one man had formal education ranging from the 6th standard to holding a Bachelor of Arts. The sample therefore contained 6 residents who had formal education, and 5 that did not.

In addition to the above planned interviews, we had extended conversations with the school principal who guided and introduced us to the residents in their shops and houses. Furthermore, as is customary for visitors, we met with the elected village *sarpanch* (headman) who explained to us the history of the village, and the village lawyer who explained to us why he did not use computers. Finally, we were asked to attend a lunch given by a local family, where we were introduced to more village residents. The above visits and discussions were publicly observed by many residents as we moved to different locations in the village, and helped to legitimize our presence. Furthermore, the discussions revealed that the village appeared to be a promising site for future experimentation because the village heads were willing to share ideas and provide support.

Research Team. Two team members conducted the field study. The first team member had extensive experience in conducting usability and ethnographic research, and in building computational systems. Although he understood the local dialect, he did not speak it fluently and therefore played the role of the observer and recorder (henceforth referred to as the *recorder*). The other team member was an undergraduate computer science student who was fluent in the local language, had prior experience in teaching rural residents how to read, but did not have any experience in conducting interviews. To enable close interaction with the participants in the study, and to reduce unnecessary translations, the student conducted the interviews. To train the student (henceforth referred to as the *interviewer*) to conduct the interviews, the recorder demonstrated and helped the interviewer practice the use of the semi-structured format including the computer demonstrations for approximately 3 hours.

Data Collection. The interviews, which took on average one and a half hours, were conducted in Mewari (a dialect of Marwari, with vocabulary and sentence structure that is similar to Hindi), and were recorded in hand-written notes, and on a tape-recorder. The data were collected in hand-written notes by the recorder as well as by the interviewer. In addition, all the interviews were tape-recorded, and each interviewed resident was photographed using a digital camera. Two laptops were taken for the demonstrations in case of computer malfunction due to the expected heat and dust of the Rajasthan desert. We also had a printed list of the residents of the village that were eligible to vote. Because we have established a relationship with the school principal, we continue to have access to new information about the rural residents over the phone. Before the demonstration during one of the interviews (P7), our laptop crashed due to heat and dust, and had to be replaced by a spare one that we carried.

Analysis

The tape-recorded interviews were transcribed into English by the interviewer (who spoke the dialect fluently), and checked for correctness by the recorder (who was present at all the interviews, and who understood the meaning of the recordings). These transcripts were supplemented with the field notes, and the photographs were used to recall

details of the context and the participant. The recorder and the interviewer collaboratively analyzed the interview transcripts using open coding to identify and categorize emergent concepts. This approach was used to ensure that the emergent concepts were grounded in the data, and therefore consistent with grounded theory[20]. In addition, specific phrases in the transcription that related to a description or use of a computer were highlighted and discussed in relationship to the demographics of the participants. After transcription, the recordings were unfortunately lost.

Results

In your view, what is a computer? *(Responses to Question-1 and Question-3 before and after the demonstration).* The goal of asking Quesiton-1 was to obtain a baseline understanding of how the residents perceived computers, and the goal of asking Question-3 was to understand how the answers changed after seeing demonstrations of computer applications. We assumed that all residents would have more difficulty describing a computer before the demonstration, compared to after.

Our analysis of responses to Question-1 revealed that 6 (P1-P6) of the 11 participants provided rich descriptions of computer use. These descriptions were either examples of computer uses (e.g., makes copies, does accounts, storing and retrieving information) or computer value (e.g., good thing, useful to get a job). In this group, there were no qualitative difference between the men and women, nor a difference between those who had used a computer versus those who had not. For example, a student (P6) who had used a computer said "it is used for healthcare", and an older participant (P3) who had never used a computer said "a computer is used to keep accounts".

In contrast, 3 participants (P7, P9, P11) had difficulty providing an answer to the question. For example, P11 said:

"I haven't seen [a computer] before. Some people who go to cities for studies talk about it".

An exploration of demographic variables of these participants suggested that formal education might provide an explanation for this difference. As shown in Table 2, the 6 participants who had a formal education (shown in the top 6 rows) all provided rich answers. In contrast, 3 of the 5 participants who did not have a formal education had less descriptive answers. Because four of the five participants who had no formal education were women, their lack of response to the question might have been caused because of their discomfort in interacting with the male interviewer. However only one woman was initially shy, but overcame her shyness as the interview progressed. The other women were outspoken and displayed no difficulty in interacting with us. Formal education could also be associated with other variables such as freer interaction with other members of the village, which needs to be explored through future research.

The last column of Table 2 shows the responses to Question-3 (asked after the computer demonstration). As shown, those with formal education had responses to Question-3 that did not vary greatly from Question-1. In contrast, three

	ID	Responses to Question-1 (pre-demo)	Responses to Question-3 (post-demo)
Formal Education	P5	A computer is a very good thing. Can use it for all mathematical problems. Can do all accounting problems, and whatever a computer does is correct. It can also be used for literacy.	This question was inadvertently not asked again to P5.
	P6	Used for healthcare, bank, business, games. It does all the work efficiently.	Computer can be used for literacy. Parents can be motivated to help teach their children.
	P2	It's a good thing, can get news.	It is a very good thing. If you learn it then it is a very good thing.
	P1	Computer is a good thing. It is something good to learn.	Computer is a useful thing.
	P3	The computer is used for keeping accounts. A recent phenomenon.	It is a good thing. It is capable of keeping accounts and details of customers. It's good for business
	P4	It is important to know about computer.	It is a good thing. You can talk to people through it. It can be used to keep accounts in the shop.
No Formal Ed. (illiterate and marginally literate)	P8	It is like a T.V.	We should learn to use a computer.
	P9	Does not know.	It is a useful thing.
	P10	Computer is a good thing. The knowledge of kids will increase through it. We can get information of other places.	It's a good thing. One should learn it. Its good that I have learnt about it.
	P11	Do not know what a computer does. People who come from cities talk about it.	It is a good thing. It can be used for accounting and also literacy.
	P7	No idea. Heard the word for the first time.	If you work hard you can learn a computer. It is a type of machine. Can be useful in farming.

Table 2. Responses to Question-1 and Question-3 sorted by formal education.

of the residents with no formal education (who had no answer for Question-1), had responses for Question-3 that were different from Question-1. P9 stated that a computer was a "useful thing", P11 stated that a computer was a "good thing", and P7 stated that a computer was a "machine" (which was the only response that did not fall in the categories of use and value). These participants were also visibly excited about the demonstration, and the ability to interact with the laptop. For instance, P7 without a formal education stated that if we taught her which keys to press on the keyboard to perform various tasks, she would master how to use the computer in a year. The computer demonstration therefore appeared to have positively impacted the responses of the residents with no formal education to engage more fully with the question.

The above results suggest that our assumptions need to be revised. We had assumed that all participants would have more difficulty responding to Question-1 compared to Question-2. However, we found that only three participants with no formal education had some difficulty in answering Question-1. The results also revealed that answers were more about use, rather than a definition (e.g., a computer is a machine) or an analogy (e.g., a computer is like a TV).

In your view, how can a computer be useful to you? (Responses to Question-2 and Question-4 before and after the demonstration). The goal of asking Question-2 was to probe how residents perceived the use of computers before seeing the computer demonstrations, and the goal of asking Question-4 was to probe whether the residents could extrapolate their perceptions of computer use to beyond what they saw in the demonstrations. We assumed that adult residents would be more interested in computers for their children rather than for themselves. We also assumed that all residents would have difficulty extrapolating to computer applications beyond those that we showed them.

Similar to responses to Quesiton-1 and Question-3, formal education also appeared to play a role in the responses to Question-2. Table 2 shows the data sorted by amount of formal education. While only one (P1) of the five participants with formal education did not have an answer, three of the five (P8, P11, P7) without a formal education did not have an answer. The person with a formal education that did not have an answer (P1) had the lowest degree (5th standard) of formal education in the set. Furthermore the residents with formal education had a wider range of answers.

		ID	Responses to Question-2 (pre-demo)	Responses to Question-4 (post-demo)
Formal Education	Used a Computer	P5	Entertainment, accounting, for teaching people.	Entertainment, accounting.
		P6	Entertainment, accounting, teaching people, communication (he knew about Internet), for help in studying.	Many uses.
	Never Used a Computer	P2	Used in banks, for advice on farming, listening to music and news, works like a calculator for accounts, also used in ice-cream factory.	Films, songs, wants information in Hindi, **get prices of gold and silver, get news of Pakistan. Can be used in agriculture and business.**
		P1	Has no use of a computer.	Quick, educational, useful, write letters, wants **sweater designs. Read newspaper through it. Do household activities. Do all things that have been demonstrated. Can listen to bhajans.**
		P3	Accounts, children, entertainment, and help on farming issues. Everything can be recorded on it and retrieved later.	Computer is helpful for **accounts of customers, can it help for sickness and bugs?** To order stones. In agriculture.
		P4	Makes work easy. Don't know any specific use.	Cannot be in two places at the same time. If I am in the shop, can a computer tell me **if stray cattle are grazing my fields? Can talk to brother who lives far away and also see him.** To keep accounts.
No Formal Ed. (illiterate and marginally literate)	Never Used a Computer	P8	Might be useful for children.	No answer owing to illiteracy. Need to study first and then know about computers.
		P9	Send something to a far-away place.	Audio missing.
		P10	Has some good use. Keep accounts, details of school fees of kids.	Useful for math, accounts, teaching, **no paper. Kids shall become intelligent through its use. Better option for photographs as it is quick and cheap. Used for communication.**
		P11	No answer.	Math. For literacy purposes. Accounts.
		P7	No answer.	Other ladies in group**: Learn stitching, painting sarees,** Only the uses that were demonstrated.

Table 3. Responses to Question-2 and Question-4 sorted by formal education. Bolded text denotes new uses of computers not mentioned in the response to Question-2, or shown in the demonstration.

The last column of Table 3 shows the responses to Question-4. Our analysis showed that there appeared to be differences in the answers for Question-4 between those who had used a computer and those who had not. P5 and P6 (students who had used a computer for three months in their school) had many computer uses before and after the demonstration. However, neither of them extrapolated to new uses beyond the demonstration. In contrast, P1, P2, P3, and P4 (all of whom had formal education, but had not used a computer) extrapolated to new uses beyond the demonstration. These responses are shown in bold font in Table 3. P2 mentioned that he would like to get news about Pakistan and prices of gold and silver; P1 mentioned that she wanted to learn how to knit new designs of sweaters to sell in the village; P3 wondered whether computers could be used to solve sickness and problems with bugs, and wanted to do accounts for customers; P4 wanted to know whether a computer could tell him if stray cattle were eating plants on his farm, when he was away in his shop:

Answer Categories	Q-2	Q-4
Accounts/Book keeping	5	6
Teaching (unspecified, knitting, etc.)	4	5
Entertainment (music, videos)	4	3
Communications	2	4
Advise on Farming	2	3
News	1	1
No paper used	0	1
Domestic Work	0	1
For Children	2	0
Prices	0	1
Insects (monitoring, control)	0	1
Healthcare	0	1
No Use	2	0

Table 4. Categories of answers to Question-2 and Question-4 sorted by total frequency.

"Right now I am in my shop. But I also have a farm. Is it possible that I can know about my farm from here? If stray cattle are grazing my fields, will I come to know about it?"

There was even some extrapolation by residents that had no formal education. P7 was sitting in a group of other women similar to her, who interjected in the discussion. They mentioned that they would be very interested in using computers to learn how to stitch and paint *sarees* (an Indian dress). P10 stated that computers did use paper, but it was not clear how this connected to a use of computers. Table 4 shows a list of the wide range of computer use categories that the residents provided for both questions. The total frequencies show that teaching, accounts/bookkeeping, and entertainment, appear to be the most frequent categories overall mentioned by the participants.

Our assumption that the adults would mention computers mostly in the context of their children needs to be revised. Only three adults mentioned children explicitly, and in each case it did not appear like it was their primary motivation. Almost all computer applications that they mentioned appeared to be relevant to them personally. This might be due to the words used in the question which were focused on the participant. However, if the adults perceived computers as being difficult to use and only useful for their children's future, then we believe that such a sentiment would have been expressed. Overall, the tone and content of the discussions suggested that computers were perceived as good and useful to them personally. Our assumption that residents would not extrapolate the demonstrations to new applications also needs to be revised. We found that participants with formal education, but with no former experience in using computers, generated the most extrapolations. Furthermore, two participants, despite having no formal education or experience using computers, did provide some extrapolations after the demonstration.

Observations during the Demonstrations. Observations during the computer and digital camera demonstrations provided several insights about the emotional content and context of the responses. Although all participants had a conception of a camera, they showed excitement when they saw digital photographs of their village on the laptop screen, and spoke out aloud the contents of each location that they recognized. Only one resident (P6), who was the youngest (14 years) in the group, said he had previously seen a digital camera with a tourist. The residents stayed attentive throughout the demonstrations, and only one of the six women displayed initial reluctance to answer the questions. None of the residents showed any reluctance to interact with the laptop when asked to change information in the spreadsheet.

Several questions were raised about the cost of a computer, and one resident said that he could not afford a computer that was above Rs. 1000 (~$20). While there were several comments about the desire to learn how to use a computer, and requests for computers in Hindi, there were no questions about how the computer worked. The concept of a mouse and keypad were easily grasped by all. The two students (P5 and P6) who had experience in computers used both hands during typing, were facile with Word and Excel, and used keyboard shortcuts like ctrl-c. However, understandably, the residents with no formal education had no conception that the keyboard contained characters used to create words. For example, one woman (R10) wanted to learn the "sequence of keys" to press to enable her to do various tasks on the computer. She also enthusiastically stated that if she was taught how to use the computer, she in turn would teach other women in the village. The interviewer then explained that the computer

keys were used to type characters, which needed skills of reading and writing to be used. The interviewer then began to explain the importance of becoming literate. However, the discussion revealed that the woman had little motivation to learn how to read. In fact, besides this interchange regarding literacy, the topic of literacy was never raised by any of the residents.

Overall, given the richness of the responses, there was a strong positive sentiment towards computers which was genuine and did not appear to be the result of the "novelty effect" or trying to please visitors. While this result is congruent with other studies on ICT usage in India[3,11] and in other developing countries[21], practical issues related to cost, language, and literacy need to be addressed through creative solutions.

Discussion

Our analysis of the rural residents of varying educational background and prior experience suggest that many of our assumptions need to be revised. In addition, the results of using the study design provided implications for medical informatics.

Revising Prior Assumptions. As discussed in the Method section, we had five assumptions about how residents would respond during the semi-structured interviews. Below we discuss how many of them need to be revised:

1. We assumed that all residents would have more difficulty describing what a computer is before the demonstration, compared to after. This was based on discussions with the team members who on the one hand believed that the question was too abstract even for experienced computer users, but on the other hand believed it could be easy for those who had never seen a computer. Our analyses suggest that only some of the participants with no formal education had difficulty describing a computer before the demonstration, but did begin to have answers after the demonstration. In contrast, those with formal education had few difficulties with the questions and provided responses which focused on computer use and value. In fact this set of respondents was interrogative in nature, and asked about various possible applications of a computer, based on their knowledge, and their occupation.

2. We assumed that adult residents would be more interested in computers for their children rather than for themselves. While numerous studies have shown that rural Indian residents have been surprisingly positive towards computer devices introduced by researchers and developers[3,11], we were less certain how rural residents who had never used computers would respond. Furthermore, we assumed that the adult residents would be biased towards computer uses for their children because of the school computers, and their general attitude towards children's education. While our questions were targeted to the participant, there were ample opportunities in the open-ended structure of the interviews to go beyond that question. However, we found that none of the adult residents mentioned their children as a primary purpose of computer use.

3. We assumed that adult residents would have the most difficulty extrapolating to computer applications beyond those that we demonstrated. This was because we expected that the younger residents (who had exposure to the computers at school) would find it easier to extrapolate to new computer uses. However, we found evidence for the opposite result; two students with formal education and computer experience provided no extrapolated examples. In contrast, the residents who had a formal education but no prior experience with computers had the most ideas about computer uses. Even those that had no formal education (or prior computer use experience) had a few extrapolated examples after the computer demonstration.

4. We assumed that younger residents would be more enthusiastic and knowledgeable about computers compared to the adults. We arrived at this assumption because several successful rural programs[3,22] have shown that children often became the most educated in the household, resulting in them becoming emissaries for change. Given that there were a few computers in the village, we assumed that the younger residents had fully exploited this opportunity, and therefore knew much more about computers compared to the adults. The results suggest that younger residents were indeed more knowledgeable with computers compared to all of the older adults, none of whom had used a computer. However, residents of all ages appeared to be very positive about computers, and many wanted to learn how to use them.

5. We assumed that the adult women would be the least responsive during the interviews. This assumption was based on our general understanding that rural Rajasthani women were conservative and would not respond to village outsiders. However, we found that only one woman (P8) initially appeared reluctant to interact with the interviewers, as evidenced by the long silences after the questions were asked. The rest of the women had little difficulty revealing their faces, answering questions, and allowing us to take photographs during the interviews.

Implications for Medical Informatics. Given the early stage of healthcare infrastructure development in rural communities across the developing world[2], there exists many opportunities for medical informaticians to make a positive impact on the health of millions of rural residents. However, for medical informaticians, the hurdles of language and culture can appear daunting from a distance. Our goal was therefore to explore the feasibility of eliciting meaningful responses about computers from a rural population despite the hurdles of language, culture, and lack of their exposure to computers. The results of the feasibility study provide implications for medical informaticians with respect to methodology, design, and impact opportunities.

From a **methodological perspective**, the results suggest that while several studies in rural communities have either used interviews early in the design process to assess user needs, and/or elicited responses of prototypes late in the process, a mixed approach could be useful for eliciting contextually-relevant responses early in the process. In particular, a demonstration of several generic applications as part of the semi-structured interview appears to engage the participants to share rich and meaningful responses including extrapolations to new uses that are relevant to their own needs. This approach appears to be especially important for respondents who do not have a formal education – it is easy for these voices not to be heard when interviews are not designed explicitly to elicit their responses.

In addition, given the simplicity of the study design, we also believe that the approach has the potential to be used in many different contexts to quickly elicit views about computers from rural residents. In fact the interviewer, despite having no experience in conducting systematic field studies, successfully executed the interviews with minimal instruction, and continues to collect data from the same site to track how the perceptions of technology are changing as more technology enters the village. This suggests that the approach has the potential to scale up leading to a grass-roots collection of data by local residents. For example, a system such as *Google Flu* (which generates global patterns of flu based on searches conducted world-wide), could enable many local interviewers using our method to upload health-related data, resulting in global health patterns across rural communities. Finally, it is important to note that heeding the advice of local researchers regarding cultural norms, establishing trust before interviewing rural residents, conducting interviews by a researcher fluent in the local language, and being prepared for computer hardware failures, each contributed to the successful execution of our overall method.

From a **design perspective,** the results of the study have also prompted some reflections. Given our resource limitations, but in keeping with many qualitative studies, the number of people we interviewed was small; however we were struck by the surprising openness to computer technology particularly the women, who despite the lack of formal education and computer exposure, engaged in genuine and thoughtful discussions about computers for their own use. This bodes well for the design of ICTs that target prevention and monitoring of health conditions. This observation is also in line with theories and empirical studies of technology adoption[7,8] that have repeatedly emphasized that perceptions of the usefulness and usability of a proposed technology are key predictors of how well that technology is adopted and accepted in the long term.

From an **impact opportunity perspective**, we hope this study will generate a broader discussion in the medical informatics community. Medical informaticians have acquired advanced training in many areas, particularly an appreciation for the complex synergy of cognition, culture, information and technology required to design effective technologies that have a positive impact on health. However, perhaps because the problems of developing nations can appear abstract, distant, and complex to tackle, this advanced informatics training tends to be more often used closer to home. Our feasibility study was an attempt to move outside of that envelope, and we were pleasantly surprised how open and helpful the local research community and rural residents were in supporting our data collection efforts, and towards technology in general. Furthermore, because of its simplicity, the study design shows evidence for developing into a sustainable model of data collection. While we do not yet have strong evidence of its generlizability, we hope that the feasibility study will inspire more medical informaticians from developed nations to venture into the developing world. Through collaboration with their counterparts in the developing world, and the use of carefully designed qualitative studies, medical informaticians could further extend the vision of Diana Forsythe by impacting the health of millions at the bottom of the pyramid.

Conclusions

Our project was designed as a feasibility study to probe how rural residents, with a wide range of formal education and prior computer experience, perceived computers and their uses. To conduct the study, we designed and executed a semi-structured interview consisting of questions about computers before and after a demonstration of computer applications.

Analysis of the tape-recorded interviews, handwritten notes, and photographs led to two key conclusions. First, the interview design enabled us to quickly elicit a broad range of computer perceptions from rural residents despite their

varying educational backgrounds and computer exposures. These results should be useful to medical informaticians and organizations who are interested in using a participatory design approach[23] to explore and introduce ICTs to rural and under-served communities[24], with the goal of improving the long-term adoption and sustainability of the solutions. Furthermore, the study helped challenge many of our assumptions about how rural residents perceive computers and their uses, and deepened our understanding of their technology readiness. Second, given the simplicity of study design and the minimal setup and training required, we believe the semi-structured interview approach we used could be useful to rapidly elicit responses in other rural settings. Future studies should explore how this approach can be elaborated to other contexts, and whether it is useful for rapidly eliciting responses from other rural residents in the developing world, with the goal of developing culturally and medically relevant ICTs.

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